applicable to various sources of the electromagnetic radiation. The description of the embodiment of Fig. 1 is thus generally inclusive for the other sources mentioned.

A1

Referring still to Fig. 1, X-rays 22 are directed to enter (penetrate) the upper surface (as oriented in the drawing) of the product. A portion of the radiation (rays), indicated at 22A, penetrates and exits the product at the opposite or lower surface of product 23. Also, as will be appreciated some of the X-rays also exit at the sides of the product. A radiation reflector 24, comprising a low Z (atomic number), high density material such as boron carbide, boron or carbon is positioned to reflect a major portion of the radiation 22B exiting the product 23 back to irradiate the product, effectively from the bottom upwardly.

Note that the term, "high density material" referred to herein, comprises boron, boron carbide, carbon or the like wherein the density is about 2 to 2.5 gr/cm3. These materials have the highest density amongst the low Z chemical elements. A low Z material is chosen because of lower absorption of the irradiating rays. It is known from physics that the absorption of X-rays and gamma-quanta rises as Z to the 5th power and diminishes by energy as E to the 3.5 power where Z is the atomic number of the absorber and E is the energy of the photons. This means that the low energy photons like X-rays or gamma rays would be highly absorbed by high Z materials. The best absorbers are high Z chemical elements and the best

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scattering materials, i.e., material with low absorption capability are low Z chemical elements. It is an additional feature of the high density material used that it diminishes the depth of penetration into the reflector material layer thereby permitting the thickness of the reflecting layer to be decreased. The reflector 24 can comprise a planar surface, and/or the reflector 24 may be contoured to better direct the reflected X-rays back to the product, as depicted in Fig. 1. The reflector should be at least three quarters (3/4)of an inch in thickness, and in the embodiment described with relation to Figs.1, the reflector is 10 cm in thickness (2.54cms equals 1inch).

A2

Reflectors of boron carbide , boron and carbon have been used in the inventive system. In one embodiment, boron carbide is used as the material for the reflector 24 since it is readily available in the marketplace. All three materials mentioned provide excellent results as a reflector of irradiation rays. Importantly, all three materials are quite stable and will not deteriorate with use. Stated in another way, all three materials can withstand the bombardment of the radiation without any substantial alteration in their photon-reflective characteristics.

A3

A comparison was made of the outputs of reflectors made from each of the mentioned materials, i.e., and it has been found that the outputs from a pure boron reflector as well as from a carbon reflector follow essentially the output curves of

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boron carbide. The boron and carbon reflectors actually provide slightly higher peak outputs at the lower energy levels with carbon providing the highest peak outputs. However, as mentioned above boron carbide is used in the embodiment shown because it is generally available, durable and practical. Boron carbide has the highest density (2.52) amongst the three materials noted herein.

In the embodiment of Fig. 1, the reflector 24 has its sides or ends 25 angled upwardly, such that the reflected beam is directed to the bottom surface of the product 23, and also to the sides of the product to provide a more uniform irradiation to the entire product. It should be understood that the reflector 24 can be configured to accommodate products of different sizes and shapes. As depicted in Fig.1A, if the product is circular, the reflector 24 can be configured to have a circular recess 26 and vertical sides 25A of selected thickness, to receive the product and more evenly reflect and re-irradiate its bottom, sides and even the top surface. In the case of electronically produced X-rays, the thickness of the reflector is chosen to effectively reflect the high energy in the broad X-ray spectrum. In the case of a gamma-ray source, it is easier to determine the proper thickness of the reflector, because the thickness can be adjusted (tuned) to only one energy.

Figs. 2 and 3 show the results of tests conducted to quantify the improvement provided by the inventive method and apparatus. The test set-up was modeled to obtain results over a wide band of voltages, i.e., for commercially useful types of

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systems. It is, of course, known that water is a standard by which useful X-ray irradiation can be measured, particularly when considering irradiation of blood transfusion bags or containers, meat food products and vegetables.

The analysis to be described in connection with Fig. 2 and Fig. 3 was on a system such as shown in Fig. 1. Specifically, a four (4) cm thick water equivalent phantom 23 comprising water equivalent polystyrene layers was positioned to receive the radiation provided from the tungsten anode of the X-ray tube 21. The results shown in Fig. 2, were obtained when the product was positioned 10 inches from the output port of tube 21. The layers were located between the X-ray tube and the reflector 24 comprised a 10 cm thick flat boron carbide member. A standard aluminum or copper filter, not shown, filtered the X-rays from X-ray tube 21.

A5

In Fig. 1, for purposes of depiction of the X-rays 22 penetrating the product 23 and the depiction of the reflected X-rays 22A, the space between the product 23 and reflector 24 has been exaggerated. Preferably, the upper surface of reflector 24 is placed in a position closely adjacent the bottom surface of the product. For example, when the product is mounted on a conveyor belt, the reflector is mounted immediately below the belt. The test results obtained in Figs. 2-4, were obtained with the upper surface of the reflector 24 in position essentially abutting the bottom

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